**AMENDMENTS TO THE CLAIMS:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor, having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, ~~so that~~ to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of ~~a specific component in a detection gas~~ oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that

defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the ~~detection~~ exhaust gas starts, for each of levels

of the ~~specific component~~ oxygen concentration, ~~the voltage level range of the limiting current region for each level of the specific component concentration being changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element,~~

adjusts the applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the ~~specific component~~ oxygen concentration within the gas concentration detection range,

~~adjusts the voltage level range of the limiting current region to a temperature considered voltage level range for each level of the specific component concentration such that the voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within the temperature considered voltage level range,~~

~~adjusts the applied voltage line so as to pass through the temperature considered voltage level range of the limiting current region for each level of the specific component concentration,~~ and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, and

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio.

2. (Canceled)

3. (currently amended) The apparatus according to claim 1, wherein said applied voltage control unit specifies an upper limit point or a point in the vicinity of said upper limit point on the limiting current region set for a minimum level of the ~~specific component~~ oxygen concentration in said gas concentration detection range and specifies a lower limit point or a point in the vicinity of said lower limit point on the limiting current region set for a maximum level of the ~~specific component~~oxygen concentration in said gas concentration detection range and sets the applied voltage line to pass through said points specified.

4. (Canceled)

5. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit devices said gas concentration detection range into a plurality of portions, and specifies, in each detection range portion, an upper limit point or a point in the vicinity of the upper limit point on the limiting current region set for a minimum level of the detection range portion specifies, in each detection range portion, a lower limit point or a point in the vicinity of the lower limit point on the limiting current region set for a minimum level of the detection range portion and sets the applied voltage line to pass through said points specified.

6. (Canceled)

7. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit determines said limiting current regions on the condition that a variation of said element current is below a predetermined quantity, and sets said applied voltage line to pass through an intermediate point of each limiting current region.

8.-10. (Canceled)

11. (currently amended) The apparatus according to claim 1, wherein ~~said apparatus is made to detect a specific component concentration in an exhaust gas emitted from a combustion engine, and~~ said applied voltage control unit sets a point at which said element current increases due to a residue of a reaction-hard component of unburned components contained in said exhaust gas as the second voltage point for each limiting current region.

12. (Canceled)

13. (Previously Presented) The apparatus according to claim 11, wherein said applied voltage control unit specifies an intermediate point between said first and second voltage points for each limiting current region to cause the applied voltage line to pass through the intermediate points.

14.-16. (Canceled)

17. (Previously Presented) The apparatus according to claim 1, wherein, on voltage-current (V-I) coordinates representing the relationship between said applied voltage and said element current therein, said applied voltage control unit makes an inclination (I/V) of the applied voltage line smaller than an inclination (I/V) of a resistance governing region determined in accordance with a direct-current internal resistance of said sensor element.

18. (Canceled)

19. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit sets different applied voltage characteristics in a gas concentration detection range in which widths of the limiting current regions are approximately equal to each other and in a gas concentration detection range in which widths of the limiting current regions are different from each other.

20.-22. (Canceled)

23. (currently amended) The apparatus according to claim 1, wherein said applied voltage control unit adjusts the temperature-considered voltage level range of the limiting current region such that a voltage level range of the limiting current region determined by a sensor output characteristic at a minimum temperature in a temperature range actually attainable in a

using environment of said sensor element and a voltage level range of the limiting current region determined by a sensor output characteristic at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range, for each level of the ~~specific component~~oxygen concentration and sets the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the ~~specific component~~oxygen concentration.

24. (Canceled)

25. (currently amended) The apparatus according to claim 1, wherein said applied voltage control unit adjusts the temperature-considered voltage level range of the limiting current region such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the temperature-considered voltage level range, for each level of the ~~specific component~~oxygen concentration and sets the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the ~~specific component~~oxygen concentration.

26. (Canceled)

27. (Previously Presented) The apparatus according to claim 25, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting a use of an output of said element current.

28. (Canceled)

29. (Currently Amended) The apparatus according to claim 1, wherein a sensor characteristic line ~~and the applied voltage line are set so as not to intersect with each other in a region outside a gas concentration detection range defined in advance~~ indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first

outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

30. (Canceled)

31. (Currently Amended) The apparatus according to claim ~~1~~ 29, further comprising an excess current detecting ~~means~~ unit that detects said element current ~~to be outside a range defined in advance~~, and a logical unit that changes, ~~said applied voltage characteristic is changed~~ when the element current detected by said excess current detecting ~~means~~ unit ~~detects said element current in the exterior of the defined range~~ is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

32. (Canceled)

33. (Currently Amended) The apparatus according to claim 31, ~~wherein, when said excess current detecting means detects said element current to be outside the defined range, said applied voltage control unit changes said applied voltage characteristic to a voltage limiting applied voltage characteristic to suppress excess voltage application to said sensor element, while~~ further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line ~~said applied voltage characteristic is delayed at the detection of said element current outside the defined range~~.

34. (Canceled)

35. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit has an applied voltage control circuit that feedback-controls the applied voltage on the basis of said element current and controls the applied voltage on the basis of the set applied voltage characteristic.

36. (Canceled)

37. (Previously Presented) The apparatus according to claim 35, wherein said applied voltage control circuit includes voltage change regulating means that regulates a change of the applied voltage.

38. (Canceled)

39. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, ~~so that~~ to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of ~~a specific component in a detection gas~~ oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that

defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the ~~detection~~ exhaust gas starts, for each of levels of the ~~specific component~~ oxygen concentration, ~~the voltage level range of the limiting current region for each level of the specific component concentration being changeable with a~~

~~temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element,~~

adjusts the applied voltage line in a predetermined concentration range of the ~~specific component~~ oxygen such that an inclination of the applied voltage line is placed between an inclination of a low-voltage side line defined by connecting the first voltage points of the limiting current regions and an inclination of a high-voltage side line defined by connecting the second voltage points of the limiting current regions,

~~adjusts the voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the specific component concentration such that voltage level ranges of the limiting current region in temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range,~~

~~adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration,~~ and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, and

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio.

40.-42. (Canceled)

43. (currently amended) The apparatus according to claim 39, wherein ~~the apparatus is a gas concentration detecting apparatus which is made to detect a specific component concentration of an exhaust gas emitted from a combustion engine, and~~ said low-voltage side line is defined by a voltage point at which, when the applied voltage to said sensor element is increased, an output of an electromotive force coming into balance with respect to the applied voltage starts, while said high-voltage side line is defined by a voltage point at which said element current increases due to the residue of a reaction-hard component of unburned components contained in said gas.

44. (Canceled)

45. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, ~~so that~~ to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of ~~a specific component in a detection gas~~ oxygen in an exhaust gas emitted

from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that

defines a characteristic of the applied voltage in advance,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the ~~detection~~ exhaust starts, for each of levels of the ~~specific component~~ oxygen concentration, ~~the voltage level range of the limiting current region for each level of the specific component concentration being changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element,~~

adjusts an applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the oxygen concentration within the gas concentration detection range,

~~adjusts the voltage level range of limiting current region to a temperature considered voltage level range for each level of the specific component concentration such that voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within the temperature considered voltage level range,~~

~~adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration,~~ and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, and

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio.

46.-48. (Canceled)

49. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, ~~so that~~ to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of ~~a specific component in a detection gas~~ oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage in advance,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the ~~detection~~ exhaust gas starts, for each of levels of the ~~specific component~~ oxygen concentration, a voltage level range of the limiting current region for each level of the ~~specific component~~ oxygen concentration being dependent on an output characteristic of the sensor element,

adjusts the voltage level range of the limiting current region to an adjusted voltage level range for each level of the ~~specific component~~ oxygen concentration such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the adjusted voltage level range,

adjusts the applied voltage line so as to pass through the adjusted voltage level range of the limiting current region for each level of the ~~specific component~~ oxygen concentration, and

controls the applied voltage according to the applied voltage line.

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, and

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio.

50. (Previously Presented) The apparatus according to claim 49, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting a use of an output of said element current.

51. (Currently Amended) The apparatus according to claim 1, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more

52. (Canceled)

53. (Currently Amended) The apparatus according to claim 39, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas~~

~~emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

54.-58. (Canceled)

59. (currently amended) The apparatus according to claim 1, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

60. (Canceled)

61. (currently amended) The apparatus according to claim 39, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

62.-66. (Canceled)

67. (Currently Amended) The apparatus according to claim 1, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted~~

~~from a combustion engine, and~~ a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

68. (Canceled)

69. (Currently Amended) The apparatus according to claim 39, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

70.-74. (Canceled)

75. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, ~~so that~~ to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of ~~a specific component in a detection gas~~ oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the ~~detection~~ exhaust gas starts, for each of levels of the ~~specific component~~ oxygen concentration, a voltage level range of the limiting current region for each level of the ~~specific component~~ oxygen concentration being dependent on an output characteristic of the sensor element,

adjusts the applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the ~~specific component~~ oxygen concentration within the gas concentration detection range,

adjusts the voltage level range of the limiting current region to an adjusted voltage level range for each level of the ~~specific component~~ oxygen concentration such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the adjusted voltage level range,

adjusts the applied voltage line so as to pass through the adjusted voltage level range of the limiting current region for each level of the ~~specific component~~ oxygen concentration, and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, and

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio.

76. (currently amended) The apparatus according to claim 75, wherein said applied voltage control unit specifies an upper limit point or a point in the vicinity of said upper limit point on the limiting current region set for a minimum level of the ~~specific component~~oxygen concentration in said gas concentration detection range and specifies a lower limit point or a point in the vicinity of said lower limit point on the limiting current region set for a maximum level of the ~~specific component~~oxygen concentration in said gas concentration detection range, and sets the applied voltage line to pass through said points specified.

77. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit devices said gas concentration detection range into a plurality of portions, and specifies, in each detection range portion, an upper limit point or a point in the vicinity of the upper limit point on the limiting current region set for a minimum level of the detection range

portion specifies, in each detection range portion, a lower limit point or a point in the vicinity of the lower limit point on the limiting current region set for a minimum level of the detection range portion, and sets the applied voltage line to pass through said points specified.

78. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit determines said limiting current regions on the condition that a variation of said element current is below a predetermined quantity, and sets said applied voltage line to pass through an intermediate point of each limiting current region.

79. (currently amended) The apparatus according to claim 75, wherein ~~said apparatus is made to detect a specific component concentration in an exhaust gas emitted from a combustion engine, and~~ said applied voltage control unit sets a point at which said element current increases due to a residue of a reaction-hard component of unburned components contained in said exhaust gas as the second voltage point for each limiting current region.

80. (Previously Presented) The apparatus according to claim 79, wherein said applied voltage control unit specifies an intermediate point between said first and second voltage points for each limiting current region to cause the applied voltage line to pass through the intermediate points.

81. (Previously Presented) The apparatus according to claim 75, wherein, on voltage-current (V-I) coordinates representing the relationship between said applied voltage and said

element current therein, said applied voltage control unit makes an inclination (I/V) of the applied voltage line smaller than an inclination (I/V) of a resistance governing region determined in accordance with a direct-current internal resistance of said sensor element.

82. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit sets different applied voltage characteristics in a gas concentration detection range in which widths of the limiting current regions are approximately equal to each other and in a gas concentration detection range in which widths of the limiting current regions are different from each other.

83. (currently amended) The apparatus according to claim 75, wherein said applied voltage control unit is adapted to again adjust the adjusted voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the ~~specific component~~oxygen concentration such that voltage level ranges of the limiting current region in temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range, and is adapted to adjust the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region.

84. (currently amended) The apparatus according to claim 83, wherein said applied voltage control unit is adapted to adjust the limiting current region to the temperature-considered voltage level range for each level of the ~~specific component~~oxygen concentration such that a voltage level range of the limiting current region determined by a sensor output characteristic at

a minimum temperature in a temperature range actually attainable in a using environment of said sensor element and a voltage level range of the limiting current region determined by a sensor output characteristic at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range, and is adapted to set the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the oxygen concentration.

85. (Previously Presented) The apparatus according to claim 75, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting a use of an output of said element current.

86. (Currently Amended) The apparatus according to claim 75, wherein a sensor characteristic line ~~and the applied voltage line are set so as not to intersect with each other in a region outside a gas concentration detection range defined in advance~~ indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the

inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

87. (Currently Amended) The apparatus according to claim ~~75~~ 86, further comprising an excess current detecting ~~means~~ unit that detects said element current ~~to be outside a range defined in advance~~, and a logical unit that changes, ~~said applied voltage characteristic is changed~~ when the element current detected by said excess current detecting ~~means~~ unit ~~detects said element current in the exterior of the defined range~~ is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

88. (Currently Amended) The apparatus according to claim 87, ~~wherein, when said excess current detecting means detects said element current to be outside the defined range, said applied voltage control unit changes said applied voltage characteristic to a voltage limiting applied voltage characteristic to suppress excess voltage application to said sensor element, while~~ further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line ~~said applied voltage characteristic is delayed at the detection of said element current outside the defined range~~.

89. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit has an applied voltage control circuit that feedback-controls the applied voltage on the basis of said element current and controls the applied voltage on the basis of the set applied voltage characteristic.

90. (Previously Presented) The apparatus according to claim 89, wherein said applied voltage control circuit includes voltage change regulating means that regulates a change of the applied voltage.

91. (currently amended) The apparatus according to claim 75, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

92. (currently amended) The apparatus according to claim 75, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

93. (currently amended) The apparatus according to claim 75, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

94. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, ~~so that~~ to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of ~~a specific component in a detection gas~~ oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that

defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the ~~detection~~ exhaust gas starts, for each of levels of the ~~specific component~~ oxygen concentration, a voltage level range of the limiting current region for each level of the ~~specific component~~ oxygen concentration being dependent on an output characteristic of the sensor element,

adjusts the applied voltage line in a predetermined concentration range of the ~~specific component~~ oxygen such that an inclination of the applied voltage line is placed between an inclination of a low-voltage side line defined by connecting the first voltage points of the limiting current regions and an inclination of a high-voltage side line defined by connecting the second voltage points of the limiting current regions,

adjusts the voltage level range of the limiting current region to an adjusted voltage level range for each level of the ~~specific component~~ oxygen concentration such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the adjusted voltage level range,

adjusts the applied voltage line so as to pass through the adjusted voltage level range of the limiting current region for each level of the ~~specific component~~ oxygen concentration, and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, and

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio.

95. (currently amended) The apparatus according to claim 94, wherein ~~the apparatus is a gas concentration detecting apparatus which is made to detect a specific component concentration of an exhaust gas emitted from a combustion engine, and~~ said low-voltage side line is defined by a voltage point at which, when the applied voltage to said sensor element is increased, an output of an electromotive force coming into balance with respect to the applied voltage starts, while said high-voltage side line is defined by a voltage point at which said element current increases due to the residue of a reaction-hard component of unburned components contained in said gas.

96. (currently amended) The apparatus according to claim 94, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

97. (currently amended) The apparatus according to claim 94, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

98. (currently amended) The apparatus according to claim 94, wherein ~~said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and~~ a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

99. (New) The apparatus according to claim 29, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

100. (New) The apparatus according to claim 1, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the

applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

101. (New) The apparatus according to claim 1, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

102. (New) The apparatus according to claim 1, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

103. (New) The apparatus according to claim 1, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

104. (New) The apparatus according to claim 1, wherein the voltage level range of the limiting current region for each level of the oxygen concentration is changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element, said applied voltage control unit adjusts the voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the oxygen concentration such that the voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range, and said applied voltage control unit adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the oxygen concentration.

105. (New) The apparatus according to claim 39, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

106. (New) The apparatus according to claim 39, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

107. (New) The apparatus according to claim 39, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

108. (New) The apparatus according to claim 39, wherein the voltage level range of the limiting current region for each level of the oxygen concentration is changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element, said applied voltage control unit adjusts the voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the oxygen concentration such that voltage level ranges of the limiting current region in temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range, and said applied voltage control unit adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the oxygen concentration.

109. (New) The apparatus according to claim 39, wherein a sensor characteristic line indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the

element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

110. (New) The apparatus according to claim 109, further comprising an excess current detecting unit that detects said element current, and a logical unit that changes, when the element current detected by said excess current detecting unit is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the

inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

111. (New) The apparatus according to claim 110, further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line.

112. (New) The apparatus according to claim 109, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

113. (New) The apparatus according to claim 39, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

114. (New) The apparatus according to claim 45, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the

applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

115. (New) The apparatus according to claim 45, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

116. (New) The apparatus according to claim 45, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

117. (New) The apparatus according to claim 45, wherein the voltage level range of the limiting current region for each level of the oxygen concentration is changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element, said applied voltage control unit adjusts the voltage level range of limiting current region to a temperature-considered voltage level range for each level of the oxygen concentration such that voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range,

and said applied voltage control unit adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the oxygen concentration.

118. (New) The apparatus according to claim 45, wherein the voltage level range of the limiting current region for each level of the oxygen concentration is changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element, said applied voltage control unit adjusts the voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the oxygen concentration such that a voltage level range of the limiting current region determined by a sensor output characteristic at a minimum temperature in a temperature range actually attainable in a using environment of said sensor element and a voltage level range of the limiting current region determined by a sensor output characteristic at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range, and said applied voltage control unit adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the oxygen concentration.

119. (New) The apparatus according to claim 45, wherein a sensor characteristic line indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level

range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

120. (New) The apparatus according to claim 119, further comprising an excess current detecting unit that detects said element current, and a logical unit that changes, when the element current detected by said excess current detecting unit is placed outside a range between a value

of the element current at the lean limit and a value of the element current at the rich limit, the inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

121. (New) The apparatus according to claim 120, further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line.

122. (New) The apparatus according to claim 119, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

123. (New) The apparatus according to claim 45, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

124. (New) The apparatus according to claim 49, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the

applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

125. (New) The apparatus according to claim 49, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

126. (New) The apparatus according to claim 49, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

127. (New) The apparatus according to claim 49, wherein a sensor characteristic line indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing

region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

128. (New) The apparatus according to claim 127, further comprising an excess current detecting unit that detects said element current, and a logical unit that changes, when the element current detected by said excess current detecting unit is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

129. (New) The apparatus according to claim 128, further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line.

130. (New) The apparatus according to claim 127, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

131. (New) The apparatus according to claim 49, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

132. (New) The apparatus according to claim 86, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

133. (New) The apparatus according to claim 75, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to

the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

134. (New) The apparatus according to claim 75, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

135. (New) The apparatus according to claim 75, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

136. (New) The apparatus according to claim 75, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

137. (New) The apparatus according to claim 94, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

138. (New) The apparatus according to claim 94, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

139. (New) The apparatus according to claim 94, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

140. (New) The apparatus according to claim 94, wherein a sensor characteristic line indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the

oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

141. (New) The apparatus according to claim 140, further comprising an excess current detecting unit that detects said element current, and a logical unit that changes, when the element current detected by said excess current detecting unit is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the

inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

142. (New) The apparatus according to claim 140, further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line.

143. (New) The apparatus according to claim 140, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

144. (New) The apparatus according to claim 94, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

145. (New) The apparatus according to claim 45, wherein a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

146. (New) The apparatus according to claim 49, wherein a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

147. (New) The apparatus according to claim 45, wherein a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

148. (New) The apparatus according to claim 49, wherein a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.